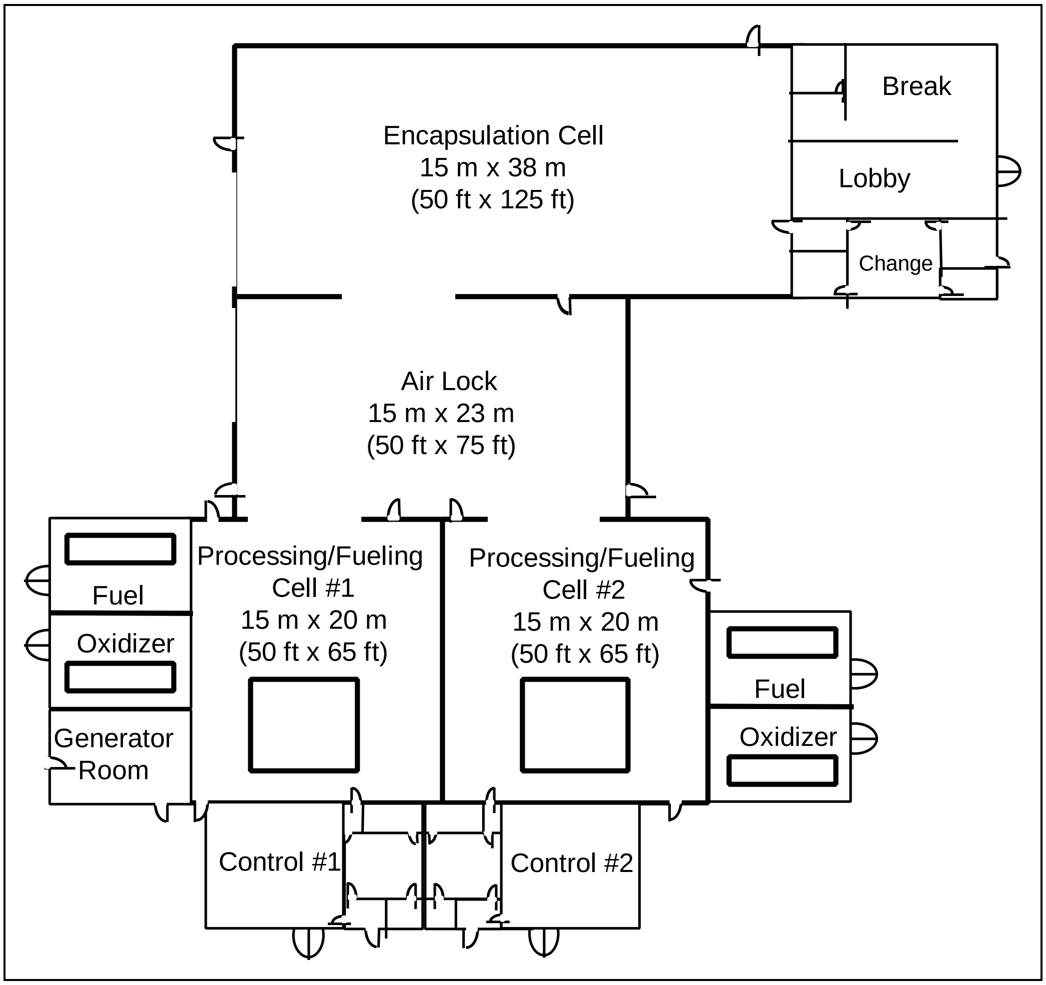

Figure A.4.2-1. Payload Processing Facility

Building 1 will have an overall area of approximately 3,900 m^2, and its major features will include:

1. Processing/fueling cells.
2. Fuel storage rooms.
3. Oxidizer storage rooms.
4. Encapsulation cell.
5. Common air lock.
6. Control rooms.
7. Garment change rooms.
8. Lobby/break area.
9. Generator room.

The processing/fueling cells, encapsulation cell, and air lock are cleanrooms will be maintained to Federal Standard 209 Class 100,000 cleanliness standards. Air filtration will be provided by pre-filters and high efficiency particulate air (HEPA) final filters. To facilitate cleanliness control, the interior wall surface of these areas will be enamel-coated gypsum board and the ceiling surfaces will be vinyl-faced gypsum panels. The floor coverings will be electrically static dissipative and will be compatible with either wheeled dollies or air bearing pallets. Temperature in the air lock, processing/fueling cells, and encapsulation cell will be maintained to 21°C ±3°C. Relative humidity will be maintained between 35%

and 60%. Card readers on personnel doors to high bays and control rooms will provide for controlled access.

A.4.2.1 Processing/Fueling Cells

The PPF will provide two separate, high bay processing/fueling cells configured to support spacecraft processing operations. In order to support spacecraft fueling operations, each cell is equipped with a 7.6 m by 7.6 m fueling island in its center. This island will be surrounded by a covered trench which will drain to one of two dedicated 18,192 L fiberglass, reinforced polypropylene tanks for emergency spill containment. To maintain cleanroom standards, access to each high bay will be controlled via a garment change room. Each processing/fueling cell will be equipped with the following features:

1. Work areas of approximately 300 m^2.
2. Motorized steel rollup access door with manual chain drive backup mechanism. Clear opening measuring 6.1 m by 12.3 m.
3. Personnel access from the air lock through a steel personnel door or from the garment change room through an air shower.
4. Emergency exit only personnel doors along outside walls.
5. Overhead traveling crane with capacity of 13,600 kg with maximum hook height of 15 m.
6. Breathing air system and protective garments for fueling crews.
7. Gas monitoring/detection system for spacecraft fuels.
8. Power receptacles.
9. Potable water hose bibbcock.
10. Vacuum ports with quick disconnect connectors and vacuum line.
11. Closed-circuit television cameras.
12. Wall-mounted telephone.

The two processing and fueling areas will have heating, ventilation, and air-conditioning systems that will provide these areas with an adequate ventilation rating. These areas will be classified Class I, Division 2, up to 3 m above the finished floor. Pits or trenches in the floor will be classified as Class I, Division 2. The areas above 3 m will not be classified in regard to electrical hazard grouping.

Operating personnel will be advised of potential safety concerns through the use of the processing facility public address system, a warning beacon system located on the exterior of the building, and a fire detection and alarm system. The warning beacon system will provide green, amber, and red beacons. The green beacon will be illuminated whenever the building is in a normal state with no fueling operations in progress. Manual switches will activate the amber beacon whenever a potentially hazardous operation is taking place. The red beacon will be activated by the toxic gas monitoring system.

Two single point toxic gas monitors will be provided in the processing, air lock and encapsulation areas, and one single point toxic gas monitor will be provided in each fuel staging cart room. The monitors are capable of monitoring for both components: N_2O_4 and monomethylhydrazine (MMH). The alarms will be sounded locally and will also activate the red warning beacon on the exterior of the building. Two alarm set points will be provided; the lower will be set at 75% of the toxic limit, and the higher will be set at 25%

of the lower explosive limit (LEL) which will activate the ventilation system purge system for the area. Remote alarm indication will be provided in the main office building.

The payload processing facility fire suppression system will be a dry pre-action system. This system will have compressed air in the lines, maintaining a "dry pipe" condition. The system will be activated by two independent but necessary actions: a smoke/heat detection alarm signal from any of the mounted detectors or from a manual pull station; and an intense heat source sufficient to melt a fusible link in the sprinkler head. The first alarm system action will open a valve which charges the system with water. A high intensity heat source must then be present to melt the fusible plug. This system will provide some protection from water damage to high value hardware in case of a false alarm.

The facility will contain a ground loop system consisting of ground rods and bare copper cable installed around the building. The loop will be tied to every other perimeter building column. A ground buss will be provided in each propellant cart area, each control room, and in the processing and encapsulation areas. Lightning protection per NFPA-78 will be provided.

Access to the facility will be limited to authorized personnel and is controlled by a card reading access control system. The access control system will be a part of the Security Information Management System.

A.4.2.1.1 Propellant Cart Storage Rooms

Two propellant cart storage rooms for each processing and fueling cell will be provided for temporary storage of fuel (N_2H_4 or MMH) and oxidizer (N_2O_4) carts and associated GSE. The rooms will have an approximate floor area of 37 m^2 with a clear vertical height of approximately 2.7 m and steel access doors measuring 2.4 m by 2.4 m. Emergency drains to the respective fuel and oxidizer containment tanks (18,168 L) will be provided in each room as well as a gas monitoring/detection system for spacecraft fuels.

A wet scrubber system will be provided for the processing fumes that may be released during the fueling operation or in case of an accident. One scrubber will be provided which can be connected to either containment tank via the vent piping system.

A.4.2.1.2 Propellant Carts/Tanks

Propellants will be delivered from the vendors in tanks approved by the U.S. Department of Transportation (DOT) in accordance with Code of Federal Regulations (CFR) 49, Transportation. Tanks planned for use are DOT 110A500W tanks (maximum 908 L capacity) or DOT 4BW tanks (maximum 454 L capacity). Both types of transport/storage tanks will be used for the direct transfer of propellants into the spacecraft by way of a closed-loop system.

A.4.2.1.3 Summary of Propellant Operating Procedures

The amount of propellant to be loaded will be a function of the spacecraft's weight, its mission, and altitude. The satellites that will be processed through the payload fueling facility will have a mass ranging from 1,500 kg to 3,500 kg. The propellant weight fraction will be between 50% and 70% of the overall payload mass.

Liquid propellant, N_2O_4 and MMH, will be received and staged (temporary storage) in DOT approved containers (i.e., in accordance with CFR 49). The typical container contains 908 liters of liquid propellant. The propellants will be stored in separate rooms until they are needed to fuel the spacecraft.

The normal load for a spacecraft requires the transfer of propellant from one tank for each fuel component. Normal practice is to have a second tank of each fuel component available as a backup.

When the spacecraft is fueled, one tank of fuel will be moved into the processing cell at a time. Following transfer of that fuel component into the spacecraft tanks, the processing cell will be cleared of all traces of that component prior to handling the next tank. This will maintain complete separation of the two components at all times.

Although the facility will have two processing cells, only one spacecraft will be fueled at any given time. Even in the instances where the operation requires the preparation of two spacecraft for a dual payload launch, the spacecraft will not be fueled simultaneously. Once fueled, the spacecraft will be moved into a separate cell for encapsulation in the payload unit.

A.4.2.2 Encapsulation Cell

An encapsulation cell will be provided in the PPF for the preparation of payload fairings and adapters, payload mating, and encapsulation. To maintain cleanroom standards, access to the encapsulation cell will be controlled via the garment change room and the air lock.

A.4.2.3 Air Lock

An air lock will be located between the encapsulation cell and the payload processing and fueling cells. This air lock will provide an isolated area to establish required cleanliness levels for new equipment arriving prior to being moved into one of the clean processing areas and will allow movement between clean areas.

A.4.2.4 Control Rooms

A control room for contractor GSE will be located adjacent to each processing/fueling cell.

A.4.2.5 Garment Change Rooms

The garment change rooms associated with each processing/fueling cell will provide an area for personnel to don cleanroom garments and fueling suits prior to entering the cells. Each room will have a floor area of approximately 27.9 m^2 and will contain personnel lockers, garment racks, fueling suit storage, cleanroom supply storage, a rest room, and benches. An air shower and a rotary brush shoe cleaner will be located at the entrance to each processing/fueling cell.

A.4.3 Solid Rocket Motor Storage

The ordnance storage in Building 2 (Figure A.4-1) will be located on the east side of the Home Port complex. (Please see Appendix B-20 for information regarding ordnance.) This building will provide storage for 24 Zenit separation motors and one spacecraft motor. Solid rocket stages include the solid propellant separation motors of the Zenit stages and a solid propellant stage that may be included in some spacecraft.

The solid rocket motor storage building will be a single story, concrete masonry structure with a steel joist roof framing system. Beyond the usual loads required for any building, this facility must also meet the design requirements for the storage of solid propellants prescribed by the Department of Defense (DOD 6055.9 STD), the Uniform Building Code, and the Uniform Fire Code. The motors to be stored in this facility are classified Hazardous Division 1.3 or mass fire hazard. A mass fire hazard is one in which the item will burn vigorously with little or no possibility of extinguishing the fire in storage situations. Explosions will normally be confined to pressure ruptures of containers and will not produce propagating shock waves or damaging blast over pressures beyond the quantity distance (Q-D) requirements prescribed in DOD (6055.9 STD) and by the Chemical Propulsion Information Agency (CPIA). The building will not be designed as an explosive resistant structure since the primary hazard is mass fire, not an explosion.

A.4.4 Quantity Distance for Home Port Facilities

The determination of Q-D requirements for safe and segregated storage and handling of spacecraft propellants is based on proposed operations and on criteria established by various governmental agencies. The proposed operating procedures used in the analysis are based on the procedures currently used at other U.S. commercial spacecraft processing facilities. The criteria used to determine Q-D requirements are contained mostly in U.S. Department of Defense (DOD) publications, but also include criteria contained in a joint agency document developed by CPIA. The criteria in these manuals was applied to assumptions made by using the procedures currently employed by the spacecraft industry. This resulted in establishing of a Q-D of 94.5 m for inhabited buildings and 56.7 m for public traffic routes. For solid propellant stage separation motors stored on site, the required Q-D is 29.3 m for both inhabited buildings and public traffic routes.

Q-D reference documents:

CPIA Publication 394 -	"Hazards of Chemical Rockets and Propellants, Volume 1, Safety, Health, and Environment."
DOD 6055.9 STD -	"DOD Ammunition and Explosives Safety Standard," dated October 1992. Establishes storage compatibility groups (SCG) for explosives. These SCGs are used to keep incompatible materials away from each other during storage. N_2O_4 is a hazard group I (fire hazard); SCG A (initiating explosive) and MMH is a hazard group III (fragment hazard); and SCG C (items that upon ignition will explode or detonate).
TM 5-1300 -	"Structures to Resist the Effects of Accidental Explosions," dated November 28, 1990. NAVFAC P-397, AFR88-2.

A.4.5 Warehouse and Storage Facilities

The high bay area in Building 4 (Figure A.4-1) will be used for storage of inert launch vehicle stages and payload fairings.

Building 5 is a small warehouse/office building that will be used to house a small machine shop and contains offices for Sea Launch resident technicians.

Buildings 7, 8, 9, and 10 offer approximately 1,486 m^2 of storage for customer supplies, equipment, and shipping containers. They are constructed of corrugated steel walls and ceilings with slab on grade floors. Each building is approximately 12 m by 30 m with a vertical height of 6.1 m. Access for equipment is through a single door in the end of each building measuring 2.4 m by 3 m. A single steel personnel access door is located on the end of each building measuring 0.9 m by 2 m. The storage buildings do not contain overhead cranes. Equipment loading is accomplished by either forklifts or wheeled dollies.

Buildings 11, 12, and 13 will be used for the storage of Sea Launch equipment and supplies. With prior coordination, additional customer storage may be arranged in these facilities if necessary.

A.4.6 Home Port Administrative Facility

The Sea Launch office in Building 3 (Figure A.4-1) will provide facilities for the resident Home Port administrative and professional staff and customers. It is a two-story structure with an area of approximately 2,230 m^2. It will consist of a marketing area, a training area, offices, conference rooms, and a break area.

A.4.7 Pier Facilities and Fueling Services

The pier provides facilities for moorage, servicing, and resupply of the Sea Launch vessels. It has a concrete surface over pilings and is approximately 335 m by 18.3 m. It has provisions for electrical power, communications, water, and sewer services to the vessels while in port. It will also have equipment for loading fuels, compressed gasses, and cryogens. Mooring provisions will allow securing the vessels to both sides of the pier for rocket integration and vessel provisioning operations. The vessels can also be secured in tandem on the west side of the pier for transfer of the integrated rocket from the ACS to the LP. Encapsulated payloads will be loaded onto the ACS using the stern ramp.

Kerosene and liquid oxygen are the primary propellants for Stage 1 and Stage 2 of the Zenit rocket and the Block DM-SL upper stage. The only primary propellant fuel loaded onto the launch vehicle prior to leaving the Home Port will be a small quantity of kerosene on the Block DM-SL upper stage. The remainder of the kerosene and all the liquid oxygen will be carried in bulk storage tanks on the LP and transferred to the ILV at the launch location.

Liquid oxygen, liquid nitrogen, and pressurized gaseous helium will be commercially procured for delivery to the Home Port pier in the supplier’s mobile equipment. This equipment is designed to meet the applicable requirements for highway transport set by DOT standards in CFR 49. To support their mobile equipment, the supplier may also provide generic equipment that meets appropriate standards.

The following approximate quantity of material will be required for each launch cycle:

Oxygen -	500 metric tonnes
Nitrogen -	240 metric tonnes
Helium -	1 metric tonne
Kerosene (RP-1) -	120 metric tonnes

A.5 ROCKET LAUNCH AND TRACKING OPERATIONS

A.5.1 Zenit Stage 1 and Stage 2 Operations

Zenit first and second stage flight operations are completely automatic. For a typical GTO mission, duration of Stage 1 flight is approximately 2 min and 30 sec, while Stage 2 separates at about 8 min and 41 sec into the mission. A flight event timeline is included in table A.5.1-1.

Table A.5.1-1. Typical Mission Event Times - GTO Mission

Time (min:sec)	Event
00:00	Liftoff
00:08	Begin pitch hover
01:04	Maximum dynamic pressure
01:49	Stage 1 begin gradual throttle to 75%
02:09	Stage 1 begin throttle to 50%
02:21	Stage 2 vernier engine ignition
02:23	Stage 1 shutdown command
02:26	Stage 1 separation
02:31	Stage 2 main engine ignition
03:37	Payload fairing jettison
07:09	Stage 2 begin main engine gradual throttle to 85%
07:29	Stage 2 main engine shutdown command
08:44	Stage 2 vernier engine shutdown
08:44	Stage 2 separation
08:49	Block DM-SL middle adapter jettison
08:54	Block DM-SL ignition #1
12:46	Block DM-SL shutdown #1 / LEO park orbit
42:46	Block DM-SL ignition #2
49:02	Block DM-SL shutdown #2/ GTO
49:17	Spacecraft separation

All Stage 1 and Stage 2 events will occur within the sensor range of either the ACS or other downrange assets. The spent stages will fall in the Pacific Ocean, well short of the coast of South America and the major coastal shipping lanes. Any deviation of flight trajectory from preprogrammed limits will cause onboard systems to automatically terminate propulsion and end the mission. This approach to flight safety obviates the need for the traditional range safety officer with a finger on the destruct button.

At second stage separation from the Block DM-SL, four solid propellant rocket motors at the base of Stage 2 will fire to back the stage away from the Block DM-SL. The pause between Stage 2 shutdown and Block DM-SL first firing will be approximately 10 sec. Half way through this period, the Block DM-SL middle adapter will be jettisoned.

Following Stage 1 engine ignition and liftoff, the aerodynamic loads will be minimized by flying with a near zero angle of attack through the high dynamic pressure (Q) regime. A maximum Q of

5,300 kgf/m^2 will occur 65 sec after liftoff. A maximum axial acceleration of four g's will occur at 110 sec. At this point the engine will gradually throttle to 75% over a period of 20 sec and then immediately will throttle to 50%, which it will hold until the engine shutdown command at 143 sec. Stage 1 separation will occur at 145 sec.

The Stage 2 engine will ignite slightly before the Stage 1 engine shutdown command, and the main engine will ignite five seconds after separation. To satisfy spacecraft thermal requirements, the payload fairing will be jettisoned at about 220 sec. At 430 sec, the main engine will gradually throttle to 85% over a period of 20 sec. This will be immediately followed by an engine shutdown command at 450 sec. The vernier engines will continue burning for an additional 75 sec, at which time they will shutdown and Stage 2 separation will occur.

A.5.2 Block DM-SL (Upper Stage) Operations

Prior to launch, the Block DM-SL onboard systems will be turned on and initialized, its oxidizer will be loaded, and power will be transferred from the LP umbilical to the Block DM-SL internal power supply. During Stage 1 and 2 flight phases, the Block DM-SL will remain inactive, except for preparations for autonomous flight. Upon reaching the interim orbit, the Block DM-SL will separate from the launch vehicle. Final insertion to a LEO park orbit will be achieved with a single main engine burn at the interim orbit apogee with no change in inclination. Prior to each subsequent main engine firing, the Block DM-SL will perform a settling burn using the attitude control system. Burn program options include, but are not limited to, two- or three-impulse insertion of the spacecraft directly into GEO, one- or two-impulse insertion into GTO, and multiple burns (up to a maximum of seven) to MEO or planetary escape. Launches from the equator will take up to eight hours to reach GEO.

Block DM-SL ignition will occur 10 sec after Stage 2 separation. Immediately after separation, the Block DM-SL middle adapter will be jettisoned. The Block DM-SL engine will burn for 230 sec to establish an intermediate LEO park orbit. After a 30 min or more coast in this park orbit, the engine will restart and burn for an additional 375 sec to inject into GTO. The 30 min coast will allow for sufficient engine thermal conditioning at the time of restart, and applies to all Block DM-SL restarts.

The LEO park orbit, combined with the equatorial launch location, may be used to deliver a spacecraft to any GTO apogee longitude in a relatively short period of time. Alternatively, the park orbit may be eliminated so that the Block DM-SL directly injects into GTO with a single 605 sec burn. This option cannot be used to deliver directly to any longitude, but it does complete the mission quickly without a coast phase or engine restart.

The Block DM-SL is capable of performing seven engine restarts and can handle a variety of missions and injection strategies. For example, intermediate and high earth orbit satellites may be delivered to either a transfer orbit or the final orbit. Additionally, the Block DM-SL has the capability to perform the phasing to the final desired location in that orbit. During the intermediate coast phases, the Block DM-SL can accommodate sun-angle pointing and continuous thermal rolls.

Tracking and telemetry return will be provided by the ACS, Altair communication satellites, existing Russian-controlled ground stations, and TDRSS. During passive flight phases, specific attitude control maneuvers (i.e., a thermal roll) may be conducted by using the attitude control/ullage propulsion engine to meet spacecraft requirements.

Optional functions include establishment of a spin rate of up to 30 rpm prior to spacecraft separation and establishment of a specific orientation at separation. The spacecraft target orbit parameters will be determined and insertion accuracy will be verified for the moment of separation. Following spacecraft insertion to the target orbit, the Block DM-SL will separate from the spacecraft and perform a contamination and collision avoidance maneuver (CCAM). Disposal options include transfer of the Block DM-SL to a higher or lower disposal orbit or establishment of a low enough orbit to ensure re-entry. The final operation of the Block DM-SL will be to vent all volatile liquids and gasses to prevent explosive destruction.

A.5.3 Range Tracking Assets

The current Sea Launch baseline range tracking assets will be centered on the ACS. Other tracking assets include: a satellite system called Altair (also called Luch or Lutch); ground tracking stations in and around Russia, including the Moscow Center; and TDRS. Other assets continue to be considered. For example, western tracking satellites and mobile tracking stations; however, these assets are not currently part of the baseline. The following paragraphs (Sections A.5.4 to A.5.7) apply to launch vehicle telemetry reception and routing. Payload unit and satellite telemetry handling baseline have not yet finalized.

During the ascent, the Zenit-3SL will be tracked by a combination of ships and satellites. For the first 410 sec the trajectory will be visible to the ACS, which is located five km from the launch platform. Throughout the remainder of the ascent to LEO park orbit, the trajectory will be tracked by TDRS. The Russian Altair tracking and data relay satellite system will provide additional coverage for subsequent Block DM-SL burns.

A.5.4 Assembly and Command Ship

The launch sequence/countdown for the ILV will begin several hours before launch and will be controlled remotely from the ACS. After the launch the ACS receives telemetry from the vehicle until it is acquired by downrange assets.

A.5.5 Tracking Downrange System

Launch vehicle telemetry will be received by TDRSS This telemetry will be collected and re-transmitted via communication satellites to the mission control center (MCC) on the ACS and to the Moscow Center.

A.5.6 Satellite Tracking System

After orbital insertion, the Block DM-SL will continue to broadcast telemetry to the Altair satellite system. When the Block DM-SL is within line-of-sight of an Altair, it will broadcast telemetry to the Altair which will relay the telemetry (via communication satellites and ground stations) to the ACS and to the Moscow Center. When the Block DM-SL is not within line-of-sight of an Altair, it will store the telemetry and transmit the data after it comes within view.